PRINCIPLE 2: NATURE USES ONLY THE ENERGY IT NEEDS

How can we learn economization from nature?

Erasmus+

AGE RANGE

11–13

DURATION

Preparation:
about 20 min.

Activity:
about 45 min. / 1 lesson

KEYWORDS

Biomimicry principles; function; energy

SUMMARY

Nature does not waste energy. How can we notice this in nature? In this module we explore how nature uses energy.

BIOMIMICRY PRINCIPLES

2 – Nature uses only the energy it needs

LEARNING OBJECTIVES

- Students understand the importance of energy within nature.
- Students understand that nature does not create waste.
- Students understand they are an interconnected part of nature.

LEARNING OUTCOMES

- Students investigate forms of energy in nature.
- Students research about energy efficiency in nature.
- Students search examples of energy from different habitats and from their previous experience.

SUBJECT(S)

This module is part of a series of modules introducing the nine principles of biomimicry. The table below shows possible KS3 Programme of Study links for all the modules. Many of the activities will also be suitable for upper KS2.

This learning module can be used flexibly within the curriculum to support key knowledge about Biology and develop working scientifically competences. The learning links with the Sustainable Development Goals and provides a broader context for student learning. It is suitable for adapting as a STEM activity or Eco Club.

Programme of Study Reference	Working Scientifically
Biology: Material cycles and energy - Photosynthesis • the reactants in, and products of, photosynthesis, and a word summary for photosynthesis. • the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere. • the adaptations of leaves for photosynthesis. Interactions and interdependencies – Relationships in an ecosystem • the interdependence of organisms in an ecosystem, including food webs and insect pollinated crops. • how organisms affect, and are affected by, their environment, including the accumulation of toxic materials. Genetics and evolution – Inheritance, chromosomes, DNA and genes • changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction. • the importance of maintaining biodiversity and the use of gene banks to preserve hereditary material.	Students successfully completing this module will have had the opportunity to access these statements: **2a, 2b, 3b, 3c, 3d, 3f**. See Annex 1 for full statements.

BIOLEARN COMPETENCES

- Students are able to abstract principles of sustainability from the way the natural world functions.
- Students are able to identify functional design in nature, develop greater awareness and appreciation for design excellence in nature, and appreciate how nature works as a system which is elegant and deeply interconnected.
- Students are able to use analogical creativity to innovate, using biological models to inspire solutions to design challenges.
- Students are able to work in groups.
- Students are more motivated in learning STEAM and experience that knowledge of STEAM can be widely used.

SUMMARY OF THE ACTIVITIES

	Activity Name	Short description	Method	Duration	Location
1	Introduction	Presenting the principle 9_principles.ppt	• Teacher presentation • Discussion	10	Indoor
2	Searching for energy forms	Searching for examples of energy usage in nature	• Observation	25	Outdoor, best in sunshine
3	Review	Discussion after the activity	• Discussion	10	Indoor/ outdoor

BACKGROUND FOR TEACHERS

See at Activity 1: Introduction.

For interconnections see *Nine Principles of Biomimicry* module.

Health and Safety
Appropriate consideration needs to be given to health and safety when working outdoors, but this should not prohibit regular use of the outdoor learning environment.

For guidance on using the outdoor learning environment review the Council for Learning Outside the Classroom suggestions on Plan and Deliver. CLEAPSS also provides guidance for members. We recommend you read and act on L196 – Managing Risk Assessment in Science. Finally, check your school policy on learning outside the classroom.

The Institute for Outdoor Learning provides a good overview into the risks and benefits of outdoor learning here. They also offer specific guidance and advice for schools here.

LOCATION
Indoor

TOOLS AND MATERIALS

- 9_principles.ppt; 3rd slide

PREPARATIONS

Arrange classroom for presentation and discussion.

RESOURCES

Benyus, J. M. (2002): Biomimicry – *Innovation inspired by nature.* HarperCollins Publisher, New York, U.S.A.

1| INTRODUCTION

» QUESTION

Present the slide about Principle 2: 9_principles.ppt, slide 3.

Nature takes only what it needs. So why do we not do the same? Our economy is focused on maximizing output and is a big energy consumer. We transport food around the world because that is economically cheaper. Only money seems to count in a lot of decisions, not our energy consumption and the impact this has on the natural world. How can we learn to optimize the performance of goods and services to sip energy rather than gulp it?

Explanation to 9_principles.ppt, 3rd slide:

Animals only take the nutrients they need; plants do not absorb more water than is necessary. The hamster stores as much grain as it needs over the winter; likewise, the squirrel collects sufficient hazelnuts for winter food. And if there are any seeds leftover, they become food for another animal or grows into a new tree.

The cheetah can run very fast, but only for a short distance. If catching the prey means using more energy than it puts into running, it stops running.

Predators only kill sufficient prey to meet their needs, leaving others for future meals. The wolf, for example, cannot eat a whole deer so it buries it to return and consume more later. Most people in society buy much more meat than they can consume. How much meat is stored unnecessarily in freezers? What will happen to it? How much energy and materials were necessary to produce this meat and how much energy needed to store it?

Migratory birds fly in a V-shape which creates an airflow that acts as a buoyancy force for the next bird, thereby maintaining speed and altitude with less effort. The V-shape helps birds save energy.

LOCATION
Outdoor

TOOLS AND MATERIALS

- Student worksheet: W2.1
- Teacher's page: T2.1

PREPARATIONS

This activity can be made anywhere outdoors. The more natural the environment the better.

Cut W2.1 into cards.

RESOURCES

Stier, S. (2014): *Engineering Design Inspired by Nature*. The Center for Learning with Nature, Coralville, U.S.A. https://www.learningwithnature.org/

2| SEARCHING FOR ENERGY FORMS

» DISCOVER

This activity provides students practice using analogical reasoning for bio-inspired engineering outdoors. The activity can use cards with any functions, but in this case we will use cards with energy and energy efficiency attributes (W2.1).

Go outside and form groups of 2–3 students. Give each group a card with an attribute. Their task will be to find an object in nature with the attribute about energy. At the beginning search for objects together, and then allow students to search freely for the attribute(s) on their card(s). Some possible answers can be found in T2.1.

After each group finds an object, they show each other what they have found. Ask them think and talk about energy efficiency in nature.

LOCATION
Indoor / Outdoor

PREPARATIONS

Arrange classroom for discussion.

3| REVIEW

» QUESTION

After the activity above talk with students about the principle:

- What forms of energy did you find in nature? Were they flows or stores of energy?
- What does energy efficiency mean in nature?
- Think about the principle itself; have you noticed any creature wasting energy (besides humans)?

T2.1 SEARCHING FOR ENERGY FORMS

Possible solutions

Generate energy:_____ sun
Power without pollution: _____ leaves
Insulate:_____ wood, fur
Collect sunlight: _____ leaves
Store energy: _____ seeds, fat of animals
Cool down: _____ sand
Withstand wind:_____ trees
Transfer energy: _____ streams, rivers
Warm up: _____ reptilians
Reflect the sunshine: _____ water surface
Slow down vital process (before winter): _____ some mammals
Collect energy (different ways):_____ soil, trees, animals

W2.1 SEARCHING FOR ENERGY FORMS

Cards for exploration

Generate energy	**Power without pollution**	**Insulate**
Collect sunlight	**Store energy**	**Cool down**
Withstand wind	**Transfer energy**	**Warm up**
Reflect the sunshine	**Slow down vital process (before winter)**	**Collect energy (different ways)**

ANNEX 1

Key Stage 4 Working Scientifically Statements

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

1. THE DEVELOPMENT OF SCIENTIFIC THINKING	a. the ways in which scientific methods and theories develop over time b. using a variety of concepts and models to develop scientific explanations and understanding c. appreciating the power and limitations of science and considering ethical issues which may arise d. explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments e. evaluating risks both in practical science and the wider societal context, including perception of risk f. recognising the importance of peer review of results and of communication of results to a range of audiences
2. EXPERIMENTAL SKILLS AND STRATEGIES	a. using scientific theories and explanations to develop hypotheses b. planning experiments to make observations, test hypotheses or explore phenomena c. applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments d. carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations e. recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative f. making and recording observations and measurements using a range of apparatus and methods g. evaluating methods and suggesting possible improvements and further investigations
3. ANALYSIS AND EVALUATION	a. applying the cycle of collecting, presenting and analysing data, including: i. presenting observations and other data using appropriate methods ii. translating data from one form to another iii. carrying out and representing mathematical and statistical analysis iv. representing distributions of results and making estimations of uncertainty v. interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions vi. presenting reasoned explanations, including relating data to hypotheses vii. being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error b. communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations

4. VOCABULARY, UNITS, SYMBOLS AND NOMENCLATURE	a. developing their use of scientific vocabulary and nomenclature b. recognising the importance of scientific quantities and understanding how they are determined c. using SI units and IUPAC chemical nomenclature unless inappropriate d. using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano) e. interconverting units f. using an appropriate number of significant figures in calculations